Measurements of the optical properties of soot aerosols with photoacoustic spectroscopy

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Climate models predict that soot aerosols have a significant impact on Earth's energy budget; however, the uncertainty of these predictions is large, in part, because soot in the atmosphere and in the laboratory is poorly characterized. The origin of the soot, e.g. biomass burning or high-temperature combustion, affects the composition, morphology, and optical properties of the particles. In the atmosphere, soot's optical and physical properties change as the particles combine with other atmospheric constituents, such as water vapor and sulfuric acid. We will describe a novel photoacoustic spectrometer system that measures the optical absorption cross section of various soots in diverse environments. In this laboratory study of flame-generated soot and graphite oxide aerosols, we combine photoacoustic spectroscopy, particle counting techniques, and differential mobility analysis to obtain high-precision measurements of the size-dependent optical absorption cross section of uncoated and coated nanoparticles. We investigate how the coating of soot by a nonabsorbing film of dibutyl phthalate (a surrogate for sulfuric acid) affects the particles' morphology and optical properties. We also measure the albedo (optical scattering) of aerosols ranging from black-carbon-like to brown-carbon-like using simultaneous photoacoustic and cavity ring-down techniques.